Multivalent approach to domestic hot water generation

Hotels typically have a high demand for energy due to the need to supply large volumes of hot water. Our Technical Director Andy Green evaluates different approaches to system design to achieve maximum water efficiency for reduced running costs and carbon emissions

Domestic hot water (DHW) generation is a natural target for efficiency improvement in high demand environments like hotels. The hot water usage in hotels is often characterised by extremely high peaks followed by longer periods of low demand. For example, large numbers of guests taking a shower first thing in the morning will usually be followed by very little need for hot water throughout the day. A second peak will often occur in the evening – either due to guests taking baths, or to end of service in the hotel restaurant and the cleaning down period for the kitchens.

Direct-fired water heaters

Traditionally, one of the most effective solutions to meeting the sudden peaks has been to use direct-fired condensing gas water heaters which can deliver large volumes of water in a short time to satisfy demand.

This type of system offers an efficient means of delivering a varying flow of hot water at a constant temperature to meet fluctuating demand. The benefit of this approach is that it reduces energy loss between peak periods as the system will only use energy when hot water is required.

Crucially, high-power instantaneous water heaters can deliver the required volumes of hot water with relatively small storage. Aside from the space implications, large storage volumes could present a risk of poor turnover of water and stagnation, leading to reduced water quality.

This can result in deposits clogging the system and cause corrosion which will reduce efficiency and could ultimately require a system replacement. The risk of legionella is also higher.

Water-temperature control is widely used to control the risk from legionella in hot water systems. Maintaining hot water systems at above 60ºC reduces the risk to practically zero. Indeed, units like our Andrews Water Heaters MAXXflo Evo have onboard controls that operate a legionella cycle to ensure that the whole system is brought up to pasteurisation temperature by monitoring the secondary return temperatures.

Electrification

However, as the nation works towards the future of heat, it's important to ensure that we engineer to reduce energy-related carbon emissions in our buildings – and that includes DHW generation.

We believe that applying a mix of different technologies and approaches, each appropriate for different applications, will offer a combined solution to meeting our legally-binding net zero target by 2050. The national electricity grid is decarbonising rapidly, so electrification of heat is one such approach, along with heat networks and decarbonisation of the gas grid.

In new and well-insulated buildings, the merits of applying heat pumps are well-established for heating. We view Air Source Heat Pumps (ASHPs) as the most popular and cost-effective choice of heat pump and are pleased to offer our Remeha E-HP AW ASHPs as part of our commercial heating solutions.

But there are several challenges to taking a wholly electric approach to hot water generation in hotels – namely system losses, legionella control and space.

One limitation of using 100% electrical supplies is that it will drive the design to increase the store of water to meet peak demand due to the longer recovery times required. Consequently, operational costs will be higher using this method compared with a system based on direct-fired water heaters which only uses energy whenever hot water is needed.

Added to which, currently only a small portion of ASHPs can efficiently generate temperatures high enough to store domestic hot water above legionella temperatures (60ºC or higher). This can present issues in managing legionella risk in hotels due to the ability to pasteurise accurately.

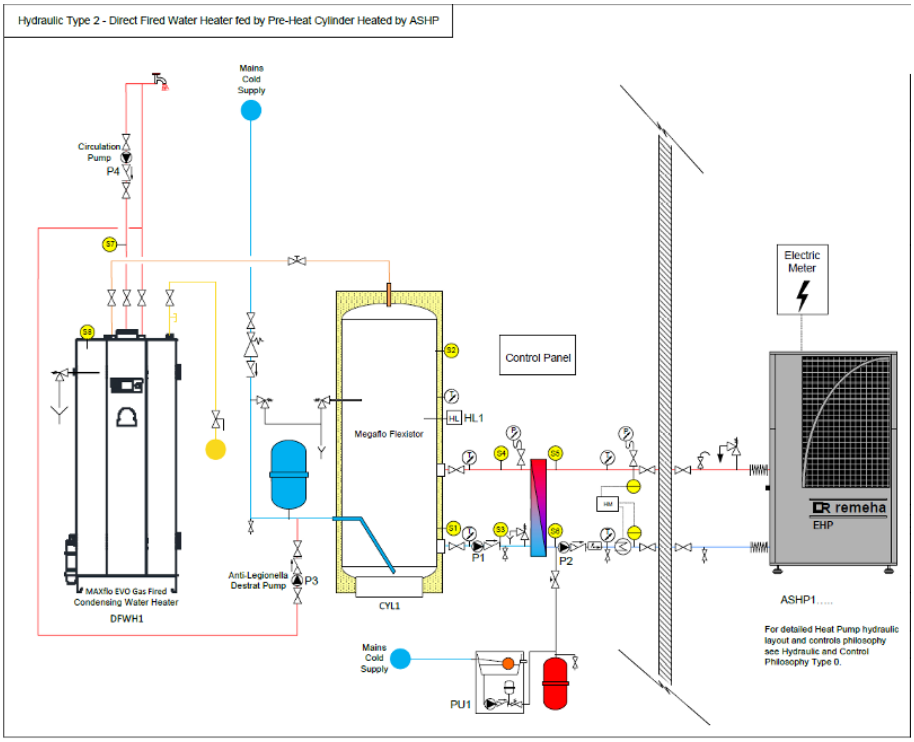
There's also the matter of where to locate the storage vessels. Post lockdown, commercially astute hotel managers might prefer to use the space to provide another bedroom for paying guests.

For all these reasons, until heat pump technology evolves, a rethink of the hot water strategy in high demand environments could well be necessary.

Multivalent solutions

In hotel buildings where there may be barriers to the full decarbonisation of heat, we see multivalent solutions as having a significant role to play in providing a solution that is both environmentally and economically more sustainable.

One option is to use ASHPs to provide a small amount of pre-heat to direct-fired water heaters (see schematic).



The heat pump, typically located outside the plant room, can be used to pre-heat a small storage vessel that is sized to deliver half the peak demand. The storage vessel, which can be charged in between the peak periods, will feed the direct-fired water heaters which will meet the hot water demand.

Let's consider three possible designs for a hotel that requires 6,000 litres of DHW in a 90-minute peak period with eight hours between each peak. The available electrical supply on site is 45kW.

If using direct-fired gas water heaters in a gas-to-gas replacement, only three MAXXflo EVO 90/302 units would be required.

In a wholly electric scenario, a 45kW heat pump or electric element would require 4,800 litres of storage to meet the 90-minute peak period. The 45kW electric unit will recover this within a little over six hours, ready for the next peak.

The third design option is a multivalent system. The electrical supply on site suits a maximum heat output of 45kW which can be used to pre-heat a small storage vessel – 2,000 litre storage in this example – sized to deliver half the peak demand. The storage vessel, which can be charged in between the peak periods, then feeds the direct-fired water heater which will meet the peak hot water demand.

The hotel's requirement for large volumes of hot water is met efficiently and safely. The design also reduces the requirement for storage by meeting over half the demand through renewable energy. In so doing, it reduces both water usage and the building's carbon footprint.

The road to net zero

At Baxi, we are committed to supporting businesses and organisations in their drive to reduce carbon emissions associated with heating and hot water. Ask our expert team how we can help you.

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